

Brian Drouin

Dr. Brian Drouin's background in chemistry and mathematics, as well as interest in molecular structure and symmetry has supported an thirteen year career in molecular spectroscopy. Beginning with microwave spectroscopy of organometallic compounds his Ph. D. work involved measurement and analyses of highly precise rotational transition frequencies of molecules in cold molecular beams. At JPL he has recorded and analyzed millimeter and submillimeter spectra of both astrophysical and atmospheric molecules while incorporating state-of-the-art hardware and software to the spectrometer. He is now a JPL research scientist and is responsible for measurements of molecular line-shape parameters for the Microwave Limb Sounder, as well as measurements of collision rates for water at very low temperatures, and THz measurements of molecules that are expected to be observable with the Herschel Space Observatory. He is the currently the primary contributor to the JPL spectral line catalog used throughout the spectroscopy and remote sensing communities.

Education

- B.S. in Mathematics, University of Wisconsin (1995)
 - B.S. in Chemistry, University of Wisconsin (1995)
 - Ph.D. in Chemistry, University of Arizona (1999)
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Research Interests

- Atmospheric Chemistry, Climate Change and Pollution (PI - Millimeter and Submillimeter Spectroscopy for Atmospheric Research)
 - Low Temperature Collisional Dynamics (PI - Measurements of State-to-State Collision Rates for Water)
 - Molecular Spectra and Structure (PI - Laboratory Spectroscopy and Analysis for Herschel, PI - Millimeter and Submillimeter Spectral Line Catalog)
 - Instrumentation for Laboratory and Field Studies (PI - Submillimeter Spectroscopy for Life Detection)
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Professional Experience

- Jet Propulsion Laboratory (1999-present)
 - Research Scientist, Science Division (2005 - present)
 - Scientist, Science Division (2001-2005)
 - California Institute of Technology Postdoctoral Scholar at JPL (1999-2001)
 - University of Arizona, Department of Chemistry (1995-1999)
 - Research Assistant, Microwave Spectroscopy (1996-1999)
 - Teaching Assistant, Physical & General Chemistry (1995-1999)
 - University of Wisconsin, (1993-1995)
 - Undergraduate Researcher, Inorganic Chemistry (1993-1995)
 - Undergraduate Researcher, Horticulture (1994-1995)
 - Undergraduate Researcher, Analytical Chemistry (1993, 1995)
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Selected Awards

- NASA Individual Outstanding Accomplishment "Significant scientific discovery by measuring the structure, spectrum, and dipole moment of HOONO" (2006)
 - NASA Group Achievement Award for the Aura Microwave Limb Sounder Ground Data System Development Team (2005)
 - Certificate of Accomplishment "Awarded in Appreciation of Your Contribution to the Aura Microwave Limb Sounder Science Assessment Team" (2005)
 - National Research Council Postdoctoral Fellowship (1999)
 - Teaching Assistant Award for excellence in teaching (1997, 1996)
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Brian Drouin - Refereed Publications (21 first author, 60 total)

1. **Drouin, B. J.**, R. R. Gamache, "Temperature Dependent Air Broadened Linewidths of Ozone Rotational Transitions" *The Journal of Molecular Spectroscopy* 251(1-2), 1-3, 2008.
2. **Drouin, B. J.**, "Temperature dependent pressure induced linewidths of O-16(2) and (OO)-O-18-O-16 transitions in nitrogen, oxygen and air", *J. Quant. Spectrosc. Radiat. Trans.*, 105 (3): 450-458, 2007.
3. **Drouin, B. J.**, "Submillimeter measurements of N₂ and air broadening of hypochlorous acid," *J. Quant. Spec. Radiat. Trans.*, 103 (3): 558-564, 2007.
4. **Drouin, B. J.**, J. C. Pearson, Adam Walters and Valerio Lattanzi "THz Measurements of Propane" *J. Mol. Spec.* 240 (2): 227-237, 2006.
5. **Drouin, B. J.**, F.W. Maiwald, "Extended THz measurements of nitrous oxide, N₂O," *J. Mol. Spec.*, 236 (2): 260-262, 2006.
6. **Drouin, B. J.**, C. E. Miller, J. L. Fry, D. T. Petkie, P. Helminger, I. Medvedev, "Submillimeter measurements of isotopes of nitric acid," *J. Mol. Spec.* 236 (1): 29-34, 2006.
7. **Drouin B. J.**, F.W. Maiwald, J. C. Pearson, "Application of cascaded frequency multiplication to molecular spectroscopy," *Rev. Sci. Instr.* 76 (9): Art. No. 093113, 2005.
8. **Drouin B. J.**, J. L. Fry, C. E. Miller, Rotational spectrum of cis-cis HOONO, *J Chem Phys* 120 (12): 5505-5508, 2004.
9. **Drouin B. J.**, Temperature dependent pressure-induced lineshape of the HC1 J=1 <- 0 rotational transition in nitrogen and oxygen, *J Quant Spectrosc Radiat Trans*, 83 (3-4): 321-331, 2004.
10. **Drouin B. J.**, J. Fischer, R. R. Garnache, Temperature dependent pressure induced lineshape of O₃ rotational transitions in air, *J Quant Spectrosc Radiat Trans*, 83 (1): 63-81, 2004.
11. **Drouin B. J.**, C. E. Miller and E. A. Cohen, Further investigations of the submillimeter spectrum of ClO, *The Journal of Molecular Spectroscopy*, 207(1), 4-9, 2001.
12. **Drouin B. J.**, C. E. Miller, H. S. P. Muller and E. A. Cohen, The rotational spectra, isotopically independent parameters, and interatomic potentials for the X1 2 3/2 and X2 2 1/2 states of BrO, *The Journal of Molecular Spectroscopy*, 205(1), 128-138, 2001.
13. **Drouin B. J.**, J. J. Dannemiller and S. G. Kukolich, Structural characterization of 'syn' and 'anti' - allyltricarbonylbromide, analyses of rotational spectra, quadrupole coupling and density functional calculations, *Inorganic Chemistry*, 39(4), 827-835, 2000.
14. **Drouin B. J.**, J. J. Dannemiller and S. G. Kukolich, The gas-phase structure of chloroferrocene from microwave spectra, *Journal of Chemical Physics* 112(2), 747-751, 2000.
15. **Drouin B. J.** and S. G. Kukolich, Microwave spectra and the molecular structure of tetracarbonylethyleneiron, *Journal of the American Chemical Society*, 121(16), 4023-4030, 1999.

16. **Drouin B.** J. P.A. Cassak and S. G. Kukolich, Microwave measurements of rhenium quadrupole coupling in cyclopentadienyl rhenium tricarbonyl, *Journal of Chemical Physics* 108(21), 8878-8883, 1998.
17. **Drouin B.** J. Molecular structure of tetracarbonyldihydroiron: Microwave measurements and density functional theory calculations, *Journal of the American Chemical Society* 120(27), 6774-6780, 1998.
18. **Drouin B.** J. N. E. Gruhn, J. F. Madden et al. Gas-phase conformational analysis of 1,4,7-trithiacyclononane, *Journal of Physical Chemistry A* 101(48), 9180-9184, 1997.
19. **Drouin B.** J. T. G. Lavaty, P. A. Cassak et al. Measurements of structural and quadrupole coupling parameters for bromoferroocene using microwave spectroscopy, *Journal of Chemical Physics* 107(17) 6541-6548, 1997.
20. **Drouin B.** J. P. A. Cassak, P. M. Briggs et al. Determination of structural parameters for the half-sandwich compounds cyclopentadienyl thallium and cyclopentadienyl indium and indium quadrupole coupling for cyclopentadienyl indium using microwave spectroscopy, *Journal of Chemical Physics* 107(10), 3766-3773, 1997.
21. **Drouin B.** J. P. A. Cassak, S. G. Kukolich, Measurements of structural and quadrupolar coupling parameters for chloroferrocene using microwave spectroscopy, *Inorganic Chemistry* 36(13), 2868-2871, 1997.

Brian Drouin - Peer-reviewed Non-first Author Publications (Spectroscopy)

1. Dick, M. J., B. J.Drouin, T. J. Crawford, J. C. Pearson, Pressure broadening of the $J = 5 - 4$ transition of carbon monoxide from 17 to 200 K: A new collisional cooling experiment, accepted to *Journal of Quantitative Spectroscopy and Radiative Transfer*, 2008.
2. Dick, M. J., B. J. Drouin, J. C. Pearson, A collisional cooling investigation of the pressure broadening of the 110 - 101 transition of water from 17K to 200K. accepted to *Journal of Quantitative Spectroscopy and Radiative Transfer*, 2008.
3. Yu S., B. J. Drouin, J. C. Pearson, H. M. Pickett, Terahertz spectroscopy and global analysis of H₃O+, *The Astrophysical Journal Supplement Series*, 125:1-6, 2008
4. Petkie D.T., M. Kipling, A. Jones, P. Helminger, I.R. Medvedev, A. Maeda, M. Behnke, B. J. Drouin, C.E. Miller. "The rotational spectra of the 6(1), 7(1), 8(1), 9(1) and 5(1)/9(2) vibrational states of H₁₅NO₃", *J. Mol. Spec.* , 251(1-2), 1-3, 2008.
5. Halfen D.T., L. M. Ziurys, J. C. Pearson, B. J. Drouin, "Direct measurments of the fundamental rotational transitions of CD and 13CH (X(2)Pi(r))" *Ap. J.* 687(1), 731-736, 2008.
6. Lattanzi V., A. Walters, J.C. Pearson, B. J. Drouin, "THz spectrum of monodeuterated methane," *J Quant. Spectrosc. Radiat. Trans.* 109 (4): 580-586, 2008.
7. Lattanzi V., A. Walters, B. J. Drouin, J. C. Pearson, "Submillimeter Spectrum of Formic Acid" *The Astrophysical Journal Supplement Series* 176(2), 536-542, 2008.
8. Xu L-H., J. Fisher, R.M. Lees, H.Y. Shi, J.T. Hougen, J.C. Pearson, B.J. Drouin, G.A. Blake, R. Braakman, Torsion-Rotation Global Analysis of the First Three Torsional States ($v_t = 0, 1, 2$) and Terahertz Database for Methanol, *The Journal of Molecular Spectroscopy* 251(1-2), 1-3, 2008.
9. Pearson J.C., C. S. Brauer, B. J. Drouin, The Asymmetric Top-Asymmetric Frame Internal Rotation Spectrum of Ethyl Alcohol, *The Journal of Molecular Spectroscopy* 251(1-2), 1-3, 2008.
10. Groner G., I. R. Medvedev, F. C. De Lucia, B. J. Drouin, Rotational spectrum of acetone, CH₃COCH₃, in the v₁₇ torsional excited state, *Journal of Molecular Spectroscopy* 251(1-2), 1-3, 2008.

11. Bruenken S., H. S. P. Mueller, C. Endres, F. Lewen, T. Giesen, B. Drouin, J. C. Pearson, H. Maeder, "High resolution rotational spectroscopy on D₂O up to 2.7 THz in its ground and first excited bending states", *Phys. Chem. Chem. Phys.*, 9 (17): 2103-2112, 2007.
12. Lattanzi, V., A. Walters, B. J. Drouin, J. C. Pearson, "Rotational spectrum of the formyl cation, HCO⁺, to 1.2 THz", *Ap. J.*, 662 (1): 771-778 Part 1, 2007.
13. Pearson J. C., B. J. Drouin "Laboratory measurement of the J=1-0 transition of CH⁺" *Ap. J.* 647 (1): L83-L86, 2006.
14. Groner, P., E. Herbst, F. C. De Lucia, B. J. Drouin, H. Maeder, "Rotational spectrum of acetone, CH₃COCH₃, in the first torsional excited state," *J. Mol. Spec.* 795 (1-3): 173-178, 2006.
15. Fry J. L., B. J. Drouin, C. E. Miller, "Rotational spectroscopy and dipole moment of cis-cis HOONO and DOONO," *J. Chem Phys.* 124 (8): Art. No. 084304, 2006.
16. Pearson, J.C., B. J. Drouin, "The ground state torsion-rotation spectrum of propargyl alcohol (HCCCH₂OH)," *J. Mol. Spec.*, 234 (1), p. 149-156, 2005.
17. Oh J. J., B. J. Drouin, E. A. Cohen, "The rotational spectrum of perchloric acid, HClO₄," *J. Mol. Spec.*, 234 (1), p. 10-24, 2005.
18. Subramanian R., C. Karunatilaka, R. O. Schock, B. J. Drouin, P. A. Cassak, S. G. Kukolich, "Determination of structural parameters for ferrocenecarboxaldehyde using Fourier transform microwave spectroscopy," *J. Chem Phys.* 123 (5): Art. No. 054317, 2005.
19. Weaver S. L. W., R. A. H. Butler, B. J. Drouin, D. T. Petkie, K. A. Dyl, F. C. De Lucia, G. A. Blake, "Millimeter-wave and vibrational state assignments for the rotational spectrum of glycolaldehyde," *Ap. J. Supp.* 158 (2): 188-192, 2005.
20. Yamada M. M., M. Kobayashi, T. Habara, T. Amano, B. J. Drouin, Submillimeter-wave measurements of the pressure broadening of BrO, *J Quant Spectrosc Radiat Trans*, 82 (1-4): 391-399, 2003.
21. Widicus S. L., B. J. Drouin, K. A. Dyl, G. A. Blake, Millimeter wavelength measurements of the rotational spectrum of 2-aminoethanol, *J Mol Spectrosc*, 217 (2): 278-281, 2003.
22. Groner P., S. Albert, E. Herbst, F. C. De Lucia, F. J. Lovas, B. J. Drouin, J. C. Pearson, Acetone: Laboratory assignments and predictions through 620 GHz for the vibrational-torsional ground state, *Astrophys J Sup* 142 (1): 145-151, 2002.
23. Toon G. C., J.-F. Blavier, B. Sen and B. J. Drouin, Atmospheric COCl₂ measured by solar occultation spectrometry, *Geophysical Research Letters*, 28 (14): 2835-2838, 2001.
24. Miller C. E. and B. J. Drouin, The X₁ 2 3/2 and X₂ 2 1/2 Potential Energy Surfaces of FO. *The Journal of Molecular Spectroscopy*, 205(2), 312-318, 2001.
25. Kukolich S. G., B. J. Drouin, O. Indris and J. J. Dannemiller, J. P. Zoller and W. A. Herrmann, Microwave spectra, DFT calculations and molecular structure of acetylenemethyldioxorhenium, *Journal of Chemical Physics* 113, 7891-7900, 2000.
26. Lavaty T. G., P. Wikrent, B. J. Drouin, et al., Microwave measurements and calculations on the molecular structure of tetracarbonyldihydroruthenium, *Journal of Chemical Physics* 109(21), 9473-9478, 1998.
27. Kukolich S. G., B. J. Drouin, P. Cassak, et al., Microwave measurements and calculations on cyclopentadienylrhodium dicarbonyl, a V-10 hindered rotor, *Organometallics* 17(18), 4105-4109, 1998.
28. Wikrent P., B. J. Drouin, S. G. Kukolich et al. Measurements of the structure of methyltrioxorhenium using microwave spectroscopy, *Journal of Chemical Physics* 107(7), 2187-2192, 1997.
29. Sickafoose S. M., P. Wikrent, B. J. Drouin, et al., Microwave spectra and quadrupole coupling

measurements for methyl rhenium trioxide, *Chemical Physics Letters* 263(1-2), 191-196, 1996.

Brian Drouin - Peer-reviewed Non-first Author Publications (MLS validation)

1. S. Wang, H. M. Pickett, T. J. Pongetti, R. Cheung, Y. L. Yung, C. Shim, Q. Li, T. Canty, R. J. Salawitch, K. W. Jucks, B. Drouin, S. P. Sander, Validation of Aura Microwave Limb Sounder OH measurements with Fourier Transform Ultra-Violet Spectrometer total OH column measurements at Table Mountain, California, *Journal of Geophysical Research*, VOL. 113, D22301, 2008.
2. Pickett H. M., B. J. Drouin, T. Canty, et al., Validation of Aura Microwave Limb Sounder OH and HO₂ measurements, *JGR - Atmospheres* 113(D16) D16S30, 2008.
3. Santee M. L., A. Lambert, W. G. Read, et al., Validation of the Aura Microwave Limb Sounder ClO measurements, *JGR - Atmospheres* 113(D15) D15S22, 2008.
4. Froidevaux L., Y. B. Jiang, A. Lambert, et al., Validation of Aura Microwave Limb Sounder HCl measurements, *JGR - Atmospheres* 113(D15) D15S25, 2008.
5. Froidevaux L., Y. B. Jiang, A. Lambert, et al., Validation of Aura Microwave Limb Sounder stratospheric ozone measurements, *JGR - Atmospheres* 113(D15) D15S20, 2008.
6. Schwartz M. J., A. Lambert, G. L. Manney, et al., Validation of the aura microwave limb sounder temperature and geopotential height measurements, *JGR - Atmospheres* 113(D15) D15S11, 2008.
7. Livesey N. J., M. J. Filipiak, L. Froidevaux, et al., Validation of Aura Microwave Limb Sounder O-3 and CO observations in the upper troposphere and lower stratosphere, *JGR - Atmospheres* 113(D15) D15S02, 2008.
8. Santee M. L., A. Lambert, W. G. Read, et al., Validation of the Aura Microwave Limb Sounder HNO₃ measurements, *JGR - Atmospheres* 112(D24) D24S40, 2007.
9. Read W. G., A. Lambert, J. Bacmeister, et al., Aura Microwave Limb Sounder upper tropospheric and lower stratospheric H₂O and relative humidity with respect to ice validation, *JGR - Atmospheres* 112(D24) D24S35, 2007.
10. Kovalenko L. J., N. L. Livesey, R. J. Salawitch, et al., Validation of Aura Microwave Limb Sounder BrO observations in the stratosphere, *JGR - Atmospheres* 112(D24) D24S41, 2007.
11. Jiang Y. B., L. Froidevaux, A. Lambert, et al., Validation of Aura Microwave Limb Sounder Ozone by ozonesonde and lidar measurements, *JGR - Atmospheres* 112(D24) D24S34, 2007.
12. Lambert A., W. G. Read, N. J. Livesey, et al., Validation of the Aura Microwave Limb Sounder middle atmosphere water vapor and nitrous oxide measurements, *JGR - Atmospheres* 112(D24) D24S36, 2007.
13. Froidevaux, L., N. J. Livesey, W. G. Read, R. J. Salawitch, J. W. Waters, B. Drouin, I. A. MacKenzie, H. C. Pumphrey, P. Bernath, C. Boone, R. Nassar, S. Montzka, J. Elkins, D. Cunnold, D. Waugh, "Temporal decrease in upper atmospheric chlorine," *Geo. Res. Lett.* 33 (23): Article L32812, 2006.
14. Froidevaux L., N. J. Livesey, W. G. Read, Y. B. Jiang, C. C. Jimenez, M. J. Filipiak, M. J. Schwartz, M. L. Santee, H. C. Pumphrey, J. H. Jiang, D. L. Wu, G. L. Manney, **B. J. Drouin**, J. W. Waters, E. J. Fetzer, P. F. Bernath, C. D. Boone, K. A. Walker, K. W. Jucks, G. C. Toon, J. J. Margitan, B. Sen, C. R. Webster, L. E. Christensen, J. W. Elkins, E. Atlas, R. A. Lueb, R. Hendershot, "Early validation analyses of atmospheric profiles from EOS MLS on the Aura satellite," *IEEE Trans. Geos. Rem. Sens.*, 44 (5): 1106-1121, 2006.
15. Pickett, H.M., B. J. Drouin, T. Canty, L. J. Kovalenko, R. J. Salawitch, K. W. Jucks, W. A. Traub, "Validation of Aura MLS HO_x measurements with remote-sensing balloon instruments," *Geo. Res. Lett.* 33 (1): Art. No. L01808, 2006.
16. Pickett, H. M., B. J. Drouin, T. Canty, L. J. Kovalenko, R. J. Salawitch, N. J. Livesey, W. G. Read,

J. W. Waters, K. W. Jucks and W. A. Traub, Validation of Aura MLS HO_x Measurements with Remote-Sensing Balloon Instruments, *Geophysical Research Letters*, 33(1), L01808, 2006.

Brian Drouin - Non-refereed First Author Publications

1. **Drouin B.J.**, H.S.P. Muller "Special issue dedicated to the pioneering work of Drs. Edward A. Cohen and Herbert M. Pickett on spectroscopy relevant to the Earth's atmosphere and astrophysics," *J. Mol. Spec.* , 251(1-2), 1-3, 2008.
2. **Drouin, B. J.** "Rotational spectroscopy at the Jet Propulsion Laboratory," Proceedings of the NATO Advanced Research Workshop on Remote Sensing for Environmental Security, held in Rabat, Morocco, November 17-November 19, 2005, *NATO Security through Science Series C: Environmental Security*, Vol. 10.
3. **Drouin B. J.**, G. Wlodarczak , J.-M. Colmont, F. Rohart, "Current status of quantitative rotational spectroscopy for atmospheric research," *Proc. Int. Workshop Crit. Eval. mm-/sub-mm- Spectrosc. Data Atmos. Obs.*, Ibaraki, Mito, Japan, January 2004.
4. **Drouin B. J.**, H. M. Pickett, "Laboratory and field studies in rotational spectroscopy at the Jet Propulsion Laboratory," *Proc. Int. Workshop Crit. Eval. mm-/sub-mm- Spectrosc. Data Atmos. Obs.*, Ibaraki, Mito, Japan, January 2004:
5. **Drouin B. J.**, W. R. Read, "Microwave session, rapporteur summary," NASA workshop on Future Needs for Atmospheric Remote Sensing, San Diego, California, USA, October 2001.